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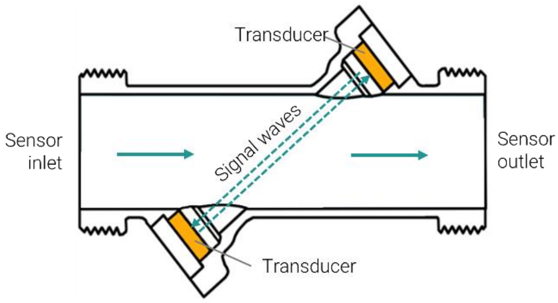
1. Measurement

A1.1. What is the measuring principle and how does it work?

The ultrasonic flow measurement principle using the time-of-flight method measures the difference in transit times of ultrasonic signals sent with and against the flow. The signal traveling in the direction of the flow moves faster than the signal traveling against it. This time difference is directly proportional to the flow velocity, enabling the calculation of the fluid flow rate.



A1.2. What is the flow measurement domain?

The flow meter, regardless of whether it's the plastic or brass version, measures within the specified flow range based on its dimensions.

Metric Units:

Dimension	DN15	DN20	DN25	DN32	DN40	DN50
Measurement range [L/min]	0.15-50	0.3-100	0.6-200	1-360	1.5-540	2-1000
Measurement range [L/h]	9-3.000	18-6.000	36-12.000	60-21.600	90-32.400	120-60.000

Imperial Units:

Dimension	1/2	3/4	1	1 1/4	1 1/2	2
Measurement range [gpm]	0.04 - 13	0.08 - 26	0.16 - 53	0.27 - 95	0.4 - 140	0.53 - 260
Measurement range [gph]	2.4-780	4.8-1600	9.6-3200	17-5700	24-8400	32-16000

The flow measurement range is bi-directional across the entire flow range. For example, the flow range for DN15 is -3000 to +3000 l/h. Note that negative flow values can only be read via Modbus and are not accessible through the Pulse or 0-5 V outputs.

A1.3. How should the accuracy specification be interpreted in the low-flow range?

The sensor's relative accuracy is slightly lower in the low-flow range. To better understand the accuracy, it is helpful to also consider the absolute flow accuracy. Here are some examples for reference:

Variant	ALSONIC Plastic DN15
Flow Rate	60 l/h = 1 l/min
Accuracy	7 % of measured value
Absolute Accuracy	60 l/h ± 4.2 l/h 1 l/min ± 0.02 l/min

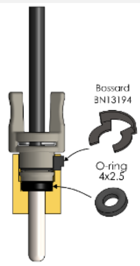
A1.4. Are there any performance differences between the ALSONIC plastic and brass variants?

The ALSONIC plastic and brass variants offer the same accuracy and pressure loss performance. However, they have slightly different operating pressure and temperature specifications.

	ALSONIC Plastic	ALSONIC Brass
Operating temperature [°C]	-20 – 90	-20 – 100
Operating pressure [bar]	10 bar	16 bar
Burst pressure [bar]	20 bar	25 bar

A1.5. What configuration is needed to use the heat metering feature?

To use the heat metering feature, the flow meter must be equipped with the internal metal sleeve PT1000 temperature sensor option. For enhanced temperature difference accuracy, this internal sensor will be paired during production with an external PT1000 temperature sensor, which is inseparably connected to the flow meter via cable. There are two options available for the external temperature sensor:

Dry Probe		Wet Probe	
	Designed to be inserted into a thermowell.		Can be directly inserted into the liquid using a special circlip and metal contour (see datasheet).

A1.6. What is the accuracy of the heat metering feature?

Heat metering accuracy is determined by combining the accuracies of flow and temperature difference measurements. According to the propagation of uncertainty, the errors are summed together. The relative error depends on the absolute temperature difference, as described by the following equation:

$$E_{tot} = E_{flow}[\%] + \frac{E_{temp}[K]}{\Delta T[K]} = 2\% + \frac{0.5K}{\Delta T[K]}$$

This leads to the following typical accuracy levels:

ΔT = 30 K	±3 %
ΔT = 10 K	±5 %

A1.7. Can the sensor's calibration be modified?

No, the sensor's calibration cannot be modified by the user. It is factory-calibrated for a specific liquid. If you need to measure different liquids or cannot ensure proper calming sections before and after the sensor, please contact us to discuss special calibration options.

2. Medias

A2.1. How can glycol detection be used?

If measuring a water-glycol mixture, configure the sensor via Modbus by setting the appropriate values at register address 327 to enable detection for propylene or ethylene glycol:

Deactivated	0
Activated for Ethylene Glycol	1
Activated for Propylene Glycol	2

Example telegram for activating ethylene glycol detection for device ID 1:

01	06	01	47	00	01	F9	E3
Dev ID	Write Command	Register Address		Data		CRC16	

The glycol concentration [%] can be then read at address 12, and the freezing point of the medium [°C] at address 14.

Example telegram for reading glycol concentration from device ID 1:

01	04	00	0C	00	01	F1	C9
Dev ID	Read Command	Register Address		Number of Words		CRC16	

A2.2. What settings need to be made to measure deionised (DI) water?

No special settings are necessary. If it is a DI water-glycol mixture, the settings can be made as described in section 2.1.

A2.3. Is the sensor capable of measuring other liquids besides water?

Yes, the sensor can measure almost any type of liquid, but it requires calibration for each specific liquid. Without this special calibration, the sensor will provide volumetric flow measurements, but they will not meet the specified accuracy. If you want to measure other liquids, please contact us.

3. Operation

A3.1. How do dirt and other impurities impact the sensor's signal and service life?

The ultrasonic measuring principle is highly robust, ensuring that dirt, impurities and particles do not affect measurement accuracy or service life. These sensors have been reliably used in heating applications for over 15 years without any issues.

A3.2. What occurs if deposition happens within the sensor?

No sensor components are in direct contact with the liquid, so deposits do not affect the measurements. Additionally, the ultrasonic signal provides a self-cleaning effect on the sensor surfaces.

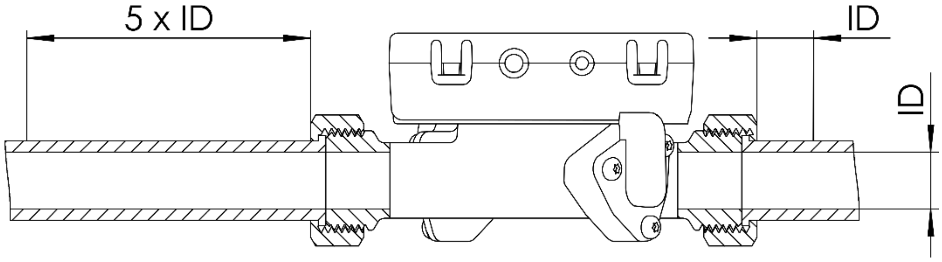
A3.3. Does the device operate effectively in an electromagnetic environment?

Yes, the device functions effectively in an electromagnetic environment without any restrictions. It has been EMC tested by an accredited laboratory in accordance with EU EMC regulations.

4. System Integration

A4.1. Is a calming section required upstream and/or downstream of the sensor?

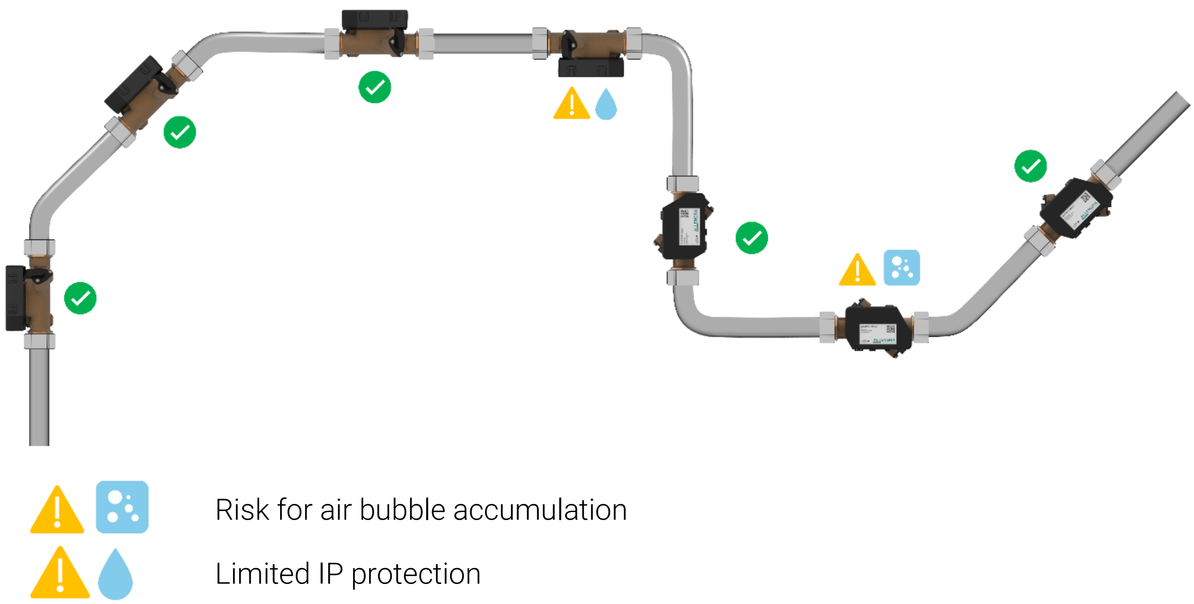
For optimal measurement accuracy, it is recommended to include an upstream calming section of 5xID and a downstream calming section of 1xID. Additionally, ensure that the inner diameter of the piping before and after the sensor matches the sensor's inner diameter, and that there are no diameter changes at the hydraulic connections.



If achieving these requirements during system integration is not feasible, it is possible to calibrate the sensor specifically for your hydraulic setup, provided that the sensor will always operate in the same configuration. This tailored calibration will help maintain measurement accuracy despite any deviations from the recommended calming sections.

A4.2. What sensor orientations are permitted?

The sensor can be used in any orientation. However, certain positions may pose a risk of air accumulation within the sensor, especially if air or gas cannot be entirely eliminated from the hydraulic system. Additionally, when the electronics housing is oriented downwards, the sensor may not provide full protection against liquid ingress (IP protection class).

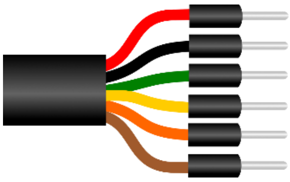


A4.3. Can the sensor be provided with an IP protection class higher than IP44?

Yes, it's possible. The electronics can be potted to achieve an IP66 protection class.

5. Electronic interfaces

A5.1. How do I properly connect the sensor to the power supply?



VCC	RED
GND	BLACK
PULSE	GREEN
0.5 – 4.5 V	YELLOW
Modbus A/D-	ORANGE
Modbus B/D+	BROWN

Ensure the power supply voltage is within 4.5 to 28 VDC to avoid damaging the flow meter. Identify the red wire as VCC and the black wire as GND. Turn off the power supply before connecting the wires. Attach the red wire to the positive (+) terminal of the power supply and the black wire to the negative (-) terminal. Turn on the power supply. The flow meter will begin operating and measuring automatically, requiring no additional setup.

To ensure a functional 0–5 V output signal, a power supply voltage of at least 5.5 VDC is required.

A5.2. What output interfaces are available on the sensor for transmitting measurement values?

The sensor is equipped with

- one pulse output,
- one 0–5 V voltage output and
- a Modbus RTU interface.

All interfaces are available simultaneously for use.

A5.3. What measurement value assignments and configurations are possible for the output interfaces?

Output	Assignments	Configuration options
Pulse output	Flow	• Pulse rate (Pulses/L)
0 – 5 V	Temperature	
	Pressure	
	Flow	
Modbus RTU	All measurements are available via Modbus, along with diagnostics and features such as bubble and glycol detection. For more details see Modbus specification.	

A5.4. What is the voltage level of the pulse output?

The voltage level of the pulse output is equal to the VCC (voltage pull-up resistor).

A5.5. How should the Pulse output be interpreted?

If the sensor has a Pulse output configuration of 1000 Pulses/L, it means that for every liter of flow, the sensor generates 1000 pulses. For example, if the flow rate is 900 L/h, the pulse frequency will be 250 Hz. This can be calculated using the formula:

$$\text{Pulse frequency [Hz]} = \frac{\text{Flow rate }[\frac{l}{h}]}{3600} \cdot \text{Pulse rate }[\frac{\text{Pulses}}{L}]$$

So, with a flow rate of 900 L/h:

$$\text{Pulse frequency} = \frac{900\,\frac{l}{h}}{3600} \cdot 1000\,\frac{\text{Pulses}}{L} = 250\text{ Hz}$$

A5.6. How should the 0 – 5 V output be interpreted?

The 0-5 V output corresponds to a linear mapping of the assigned measurement variable. For example, if the standard temperature mapping range is 0 to 90°C, a measurement of 45°C will result in a voltage output of 2.5 V.

The formula to calculate the voltage output based on the measured value is:

Assigned measurement value	Formula
Generic	$\text{Meas. Value} = \frac{\text{Upper Limit-Lower Limit}}{4\text{ V}} \cdot (\text{Meas. Voltage-0.5 V})$
Temperature 0-90 °C	$\text{Temperature [°C]} = \frac{90\text{ °C-0 °C}}{4\text{ V}} \cdot (\text{Meas. Voltage-0.5 V})$
Pressure 0-10 bar	$\text{Pressure [bar]} = \frac{10\text{ bar-0 bar}}{4\text{ V}} \cdot (\text{Meas. Voltage-0.5 V})$
Flow 9 – 3000 L/h	$\text{Flow }[\frac{L}{h}] = \frac{3000\frac{L}{h}-9\frac{L}{h}}{4\text{ V}} \cdot (\text{Meas. Voltage-0.5 V})$

6. Modbus Communication Interface

A6.1. Can the sensor be directly connected to a PC or laptop for functionality testing?

Yes, the sensor can be connected to a PC or laptop, for example, via a USB-Modbus interface. We recommend using the following interface for optimal compatibility:

- FTDI USB-RS485-WE-1800-BT (https://ftdichip.com/products/usb-rs485-we-1800-bt/)

A6.2. Which software can be used on a PC or laptop to read values via Modbus?

We recommend using QModMaster for initial testing purposes, as it is a straightforward and user-friendly software that is freely available.

Download: https://sourceforge.net/projects/qmodmaster/

Refer to Appendix 1 for a tutorial on how to read data using QModMaster.

A6.3. What are the Modbus addresses for each value on the interface?

The Modbus addresses for each value can be found in the Modbus specification. The latest version is always available on our website: Modbus Specification

A6.4. How can data with the INT32 data type, such as flow rate, be correctly read from Modbus?

Each Modbus register is 2 bytes in size (1 word). Since the INT32 data type requires 4 bytes (2 words), two registers are needed to store the data.

To read the flow value from a sensor with Modbus device ID 1, the following Modbus telegram should be used:

01	04	00	00	00	02	71	CB
Dev ID	Read Command	Register Address		Number of words		CRC16	

The sensor will return 2 words (4 bytes) of data.

Register address	0	1	→	DEZ	FLOW
Value	00 00	17 70		6000	600.0 l/h

In this example, the flow value is 0x1770, which equals 600 l/h (with a resolution of 0.1 l/h). The value in register 0 will not be used until the flow exceeds 0xFFFF (6553.5 l/h).

For instance, a flow of 10000 l/h (represented as 0x186A0) would be stored as:

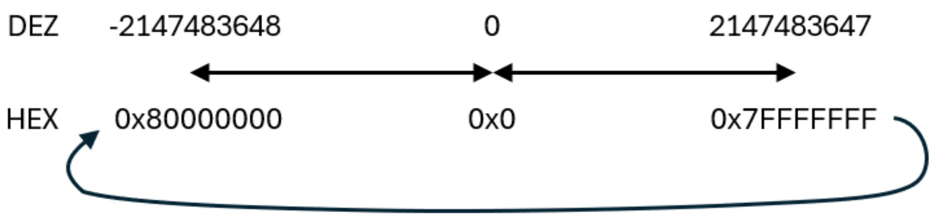
Register address	0	1	→	DEZ	FLOW
Value	00 01	86 A0		100000	10000.0 l/h

To avoid issues when reading negative flow values, refer to the following example:

Register address	0	1	→	DEZ	FLOW
Value	00 00	E8 90		59546	5954.6 l/h

Register address	0	1	→	DEZ	FLOW
Value	FF FF	E8 90		-6000	-600.0 l/h

For background, refer to how negative and positive values are stored in the INT32 data type:



To view which values are stored in INT32 data types, refer to the Modbus specification.

A6.5. How can the heat metering be configured and read?

The current power $\dot{Q}$ [kW] at Modbus address 6 is calculated according to the energy measurement configuration set at Modbus address 328:

Formula		Config.	Comment
	-	0	Energy measurement deactivated.
$\dot{Q} = c_p \rho \dot{V} \cdot$	$max(0, T_{Remote} - T_{Local})$	1	Negative values are set to zero.
	$max(0, T_{Local} - T_{Remote})$	2	
	$\lvert T_{Remote} - T_{Local} \rvert$	3	Positive, regardless of temp. difference sign.
	$(T_{Remote} - T_{Local})$	4	Positive or negative, for energy balance.
	$(T_{Local} - T_{Remote})$	5	

The current heating/cooling power $\dot{Q}$ is continuously accumulated to a heating/cooling energy Q [kWh] at Modbus addresses 506 and 508.

The energy sum for heating (Modbus address 506) adds up positive power values, while the energy sum for cooling (Modbus address 508) adds up negative power values. In configurations 1, 2, and 3, the cooling energy sum (Modbus address 508) is always 0 by definition:

Config.	Addr. 506	Addr. 508 – Cooling Energy Sum
1	$Q_{506} = \int_0^t \max(0, Q(t))\, dt$	$Q_{508} = 0$
2	$Q_{506} = \int_0^t \max(0, Q(t))\, dt$	$Q_{508} = 0$
3	$Q_{506} = \int_0^t \max(0, Q(t))\, dt$	$Q_{508} = 0$
4	$Q_{506} = \int_0^t \max(0, Q(t))\, dt$	$Q_{508} = \int_0^t \min(0, Q(t))\, dt$
5	$Q_{506} = \int_0^t \max(0, Q(t))\, dt$	$Q_{508} = \int_0^t \min(0, Q(t))\, dt$

To determine which energy measurement configuration fits to your application, following help can be used:

		Calculation method				
		Heating Only or Cooling Only		Combined Total	Separate Totals	
		Add up only positive energy values.		Add both heating and cooling energy into a single total.	Add heating and cooling energy into two separate totals.	
		Sensor position			Sensor position	
		Flow	Return		Flow	Return
Application	Heating	2	1	3	5	4
	Cooling	1	2		4	5

A6.6. How can the bubble detection feature be read out?

There are two Modbus addresses related to detected bubbles in the flow.

Modbus address 10 indicates whether gas bubbles are detected in the system.

Value	Description
0	No air detected
1	Air detected

Additionally, a qualitative value for the amount of gas bubbles in the flow can be obtained by reading Modbus address 11. The possible values and their descriptions are as follows:

Value	Description
0	No air detected
1	Small amount of air
2	Medium amount of air
3	High amount of air
4	Severe air (no flow measurement possible)

A6.7. How can I use recovery mode to restore the sensor if incorrect Modbus parameters were set?

If the device ID, baud rate, parity, or stop bits have been changed from the default settings and communication with the device is no longer possible, you can recover or modify the configuration by entering Modbus recovery mode.

To enter recovery mode, send a Modbus command using the default Modbus settings within the first second after powering up the sensor. The sensor will then revert to the default Modbus configuration and maintain it until the next restart. During this time, you can modify the Modbus settings to the desired values.

Default Modbus settings:

Device ID	1
Baudrate	115200
Parity	Even
Stopbits	1

As an example, you can read the temperature from the device within the first second by sending the following Modbus command using the default settings (baud rate 115200, parity even, and stop bits 1):

01	04	00	02	00	01	90	0A
Dev ID	Read Command	Register Address		Number of words		CRC16	

7. Compliance

A7.1. Which certificates are available?

Following certificates can be provided on request:

- Manufacturers CE Declaration of Conformity
- EMC Test Report
- Manufacturers Declaration RoHS and REACH
- Manufacturers Declaration 'Conflict Minerals' (acc. to Dodd-Frank Act)
- Manufacturers Declaration of 'No potential source of ignition' according to DIN EN 60335-2-40, sections 22.116 and 22.117
- Drinking Water Approval UBA BWGL Material Certificates
- UL Yellow Cards of Plastic Materials
-

For information on other certifications, please feel free to contact us.

8. Troubleshooting

A8.1. No pulse signal is received.

- Check power supply (see A5.1)
- Check if correct pull-up resistor 10 kΩ is installed.

A8.2. No 0-5 V signal received.

- Check power supply (see A5.1), especially ensure power supply voltage > 5.5 VDC.

A8.3. Modbus communication not working.

- Check the Modbus A/B wiring. Try swapping the A and B wires.
- Make sure the Modbus settings (Device ID, Baud rate, Parity, Stop bits) of the reading device match the sensor's configuration.

A8.4. Flow measurement shows 0 on Modbus, but there is flow in the system.

- Make sure you are reading the flow values from both registers 0 and 1. The value in register 0 will be 0 if the flow is below 6553.5 l/h. For a detailed explanation, refer to section 0.

A8.5. The measured flow has deviations compared to my reference measurement device.

- Check if the deviations fall within the accuracy range specified in the datasheet.
- Check the accuracy of the reference measurement device.
- Ensure that the calming section upstream and downstream of the sensor complies with the recommendations specified in the datasheet.

A8.6. The Modbus settings were changed, and you are unable to communicate with the sensor.

Try to reset the Modbus settings by using the Modbus recovery mode as described in A6.7.

Appendix

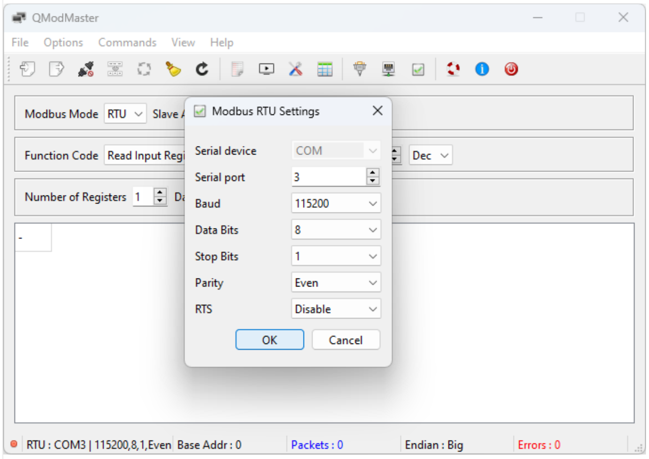
A1 qModMaster Modbus Tutorial

To easily connect the sensor to your laptop, we recommend using a USB-Modbus interface such as the FTDI USB-RS485-WE-1800-BT.

For a straightforward way to test the sensor and Modbus communication, you can use the qModMaster software. This tool provides an intuitive interface for interacting with Modbus devices. To get started:

- Download qModMaster: https://sourceforge.net/projects/qmodmaster/
- Install the Software by following the installation instructions.
- Connect your sensor to the USB-Modbus interface. Ensure the wiring follows the pinout diagram specified in the sensor's datasheet. Double-check connections to avoid errors or damage.

Configuration of the software with the correct Modbus settings



Verify the configuration settings by navigating to **Options** > **Modbus RTU**:

Select the **serial port** based on the COM port to which your Modbus interface is connected.

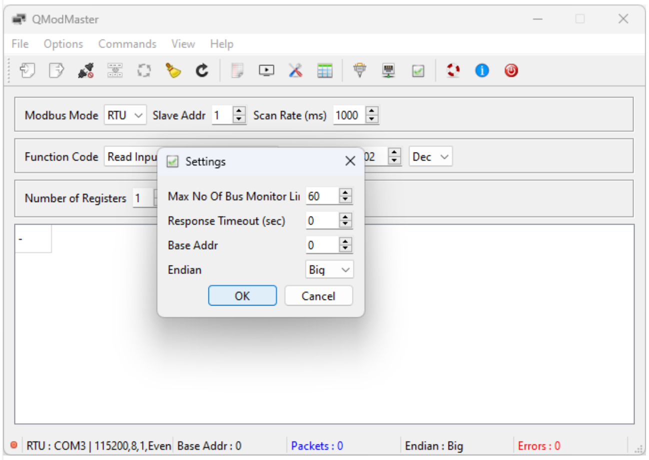
Baud 115200

Data Bits 8

Stop Bits 1

Parity Even

RTS Disable



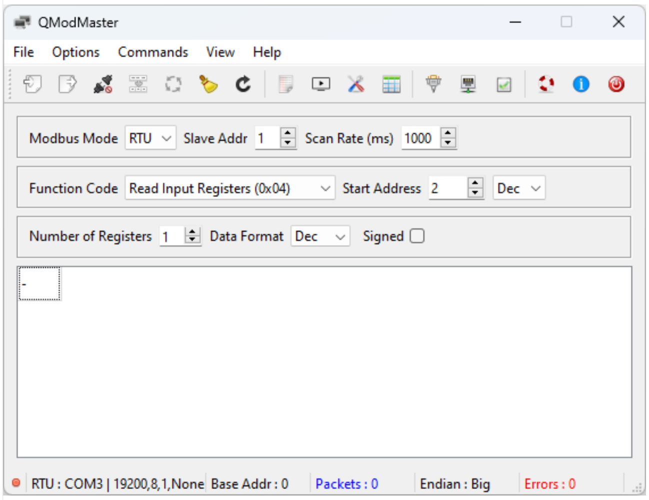
Verify or adjust settings by accessing **Options** > **Settings**:

Max No Of Bus Monitor Lines 60

Response Timeout (sec) 0

Base Addr 0

Endian Big



Verify and, if necessary, adjust the configurations in the main window:

Modbus Mode: RTU

Slave Addr: 1

Scan Rate (ms): 1000

Function Code: Read Input Registers (0x04)

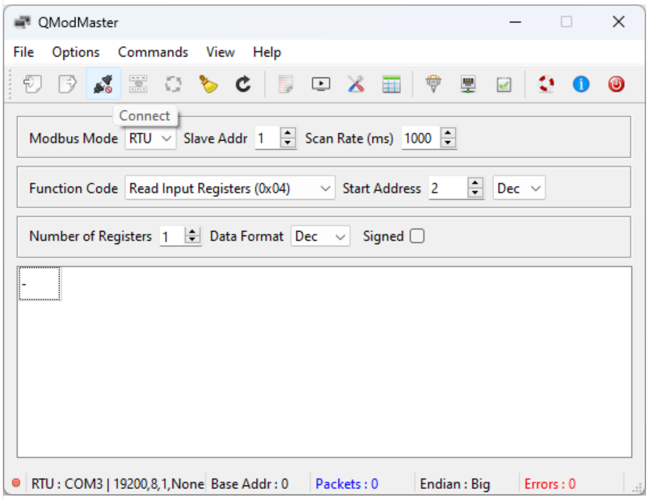
Start Address: 2 Dec

Number of Registers: 1

Data Format: Dec

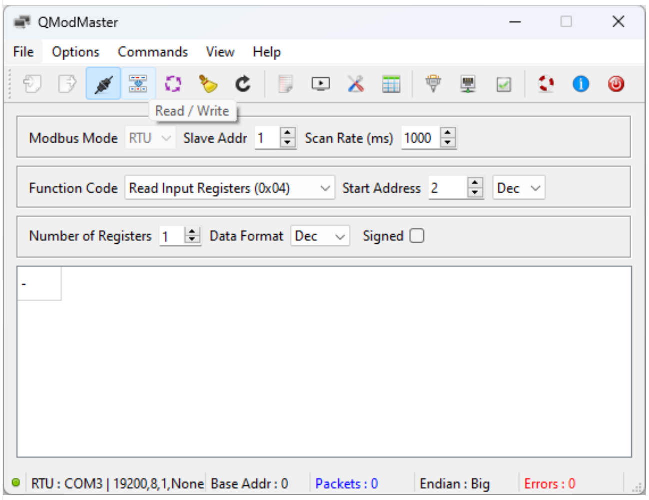
Signed: Unchecked

Establishing connection and reading out values

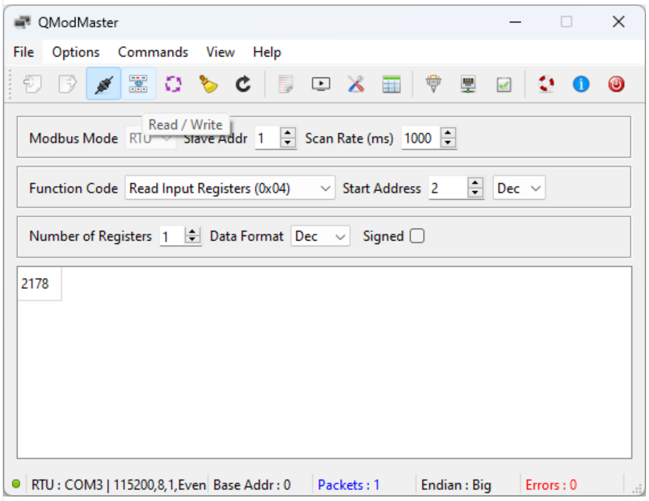


Click the "**Connect**" button to establish a connection with the sensor.

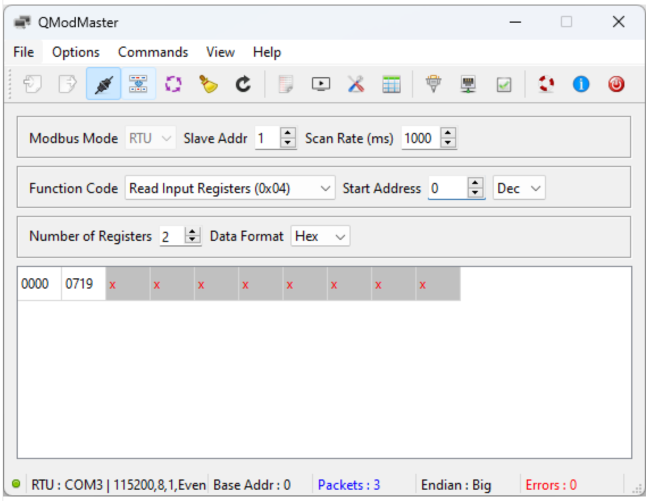
If successful, the status indicator in the bottom-left corner will change from red to green.



Next to the "**Connect**" button, you'll find the "**Read/Write**" option. Clicking this button will send a single read or write command to the sensor.



In this example, qModMaster retrieves the internal temperature measurement from Modbus address 2. The received value, "2178," represents a temperature of 21.78°C.



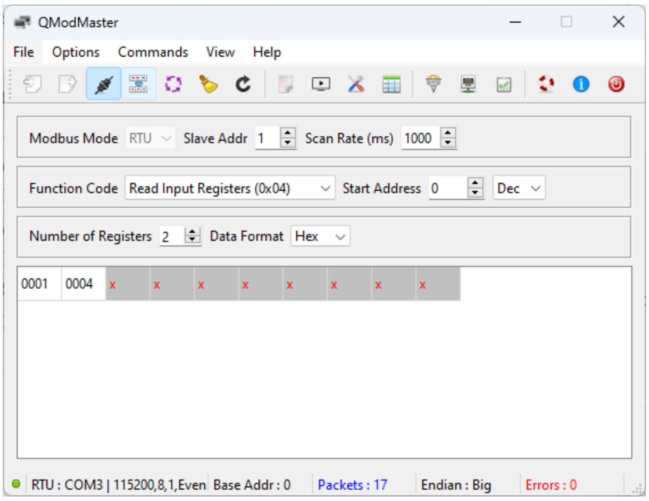
For reading volume flow with data type INT32 (see 0) at Modbus register 0 and 1 adjust following settings:

Start Address: 0 Dec

Number of Registers: 2

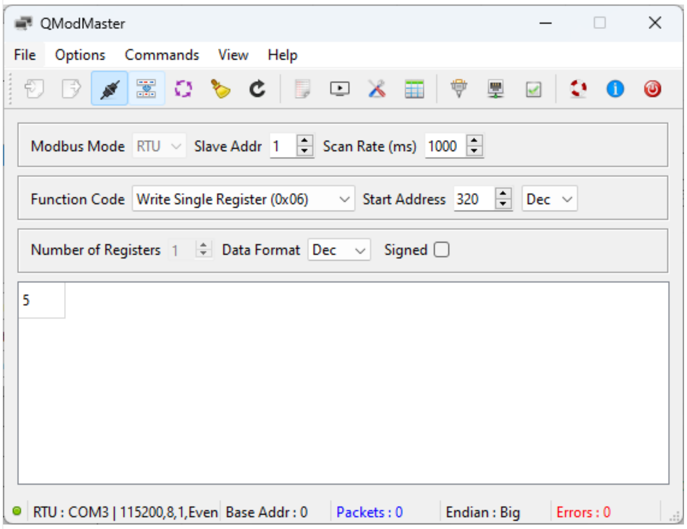
Data Format: Hex

In this example the sensor outputs “0x719” which corresponds to the flow 181.7 l/h.



At larger volume flows, both registers 0 and 1 will be used. In the shown situation the output is “0x10004” which corresponds to the volume flow 6554.0 l/h

Change Modbus Configuration (e.g. Device ID, Baudrate)



To change the device ID of the sensor, the new device id (5 in the example) need to be written to the Modbus address 320:

Function Code: Write Single Register (0x06)

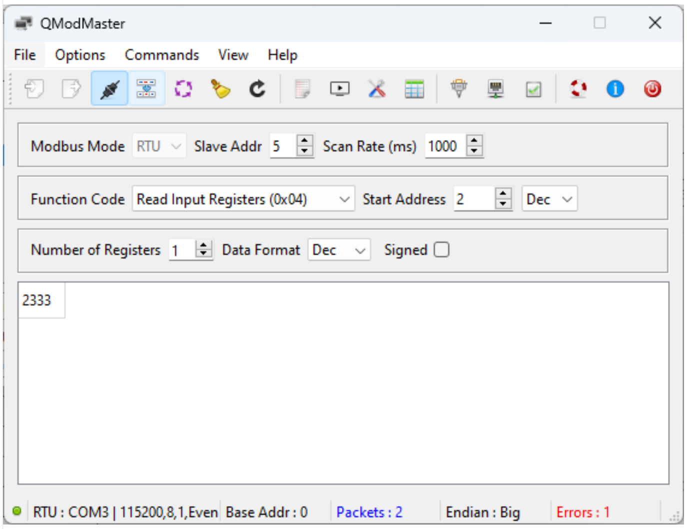
Start Address: 320 Dec

Number of Registers: 1

Data Format: Dec

Signed: Unchecked

Data: 5



To read the temperature considering the new device ID, following settings are needed:

Slave Addr: 5

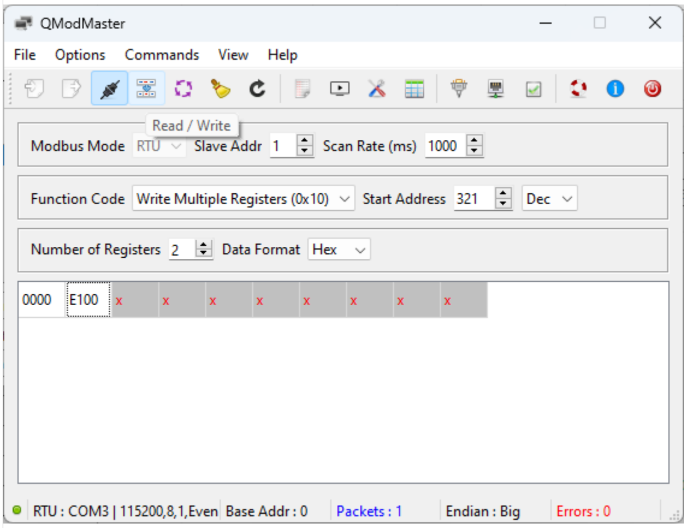
Function Code: Read Input Registers (0x04)

Start Address: 2 Dec

Number of Registers: 1

Data Format: Dec

Signed: Unchecked



To change the baudrate, it's needed to write on two registers 321 and 322. In this example the baudrate is changed to 57600 (0xE100).

Slave Addr: 1

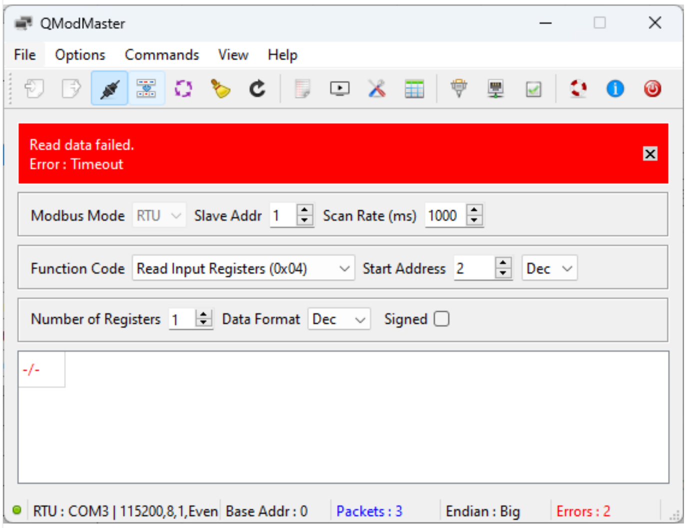
Function Code: Write Multiple Registers (0x10)

Start Address: 321 Dec

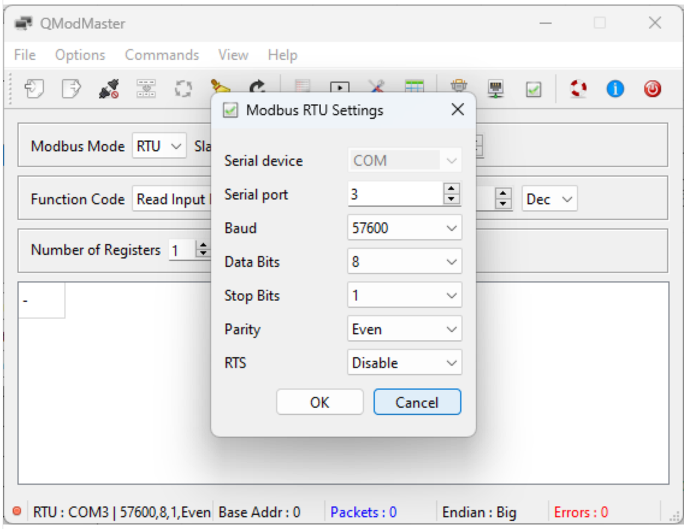
Number of Registers: 2

Data Format: Hex

Data: 0000 E100

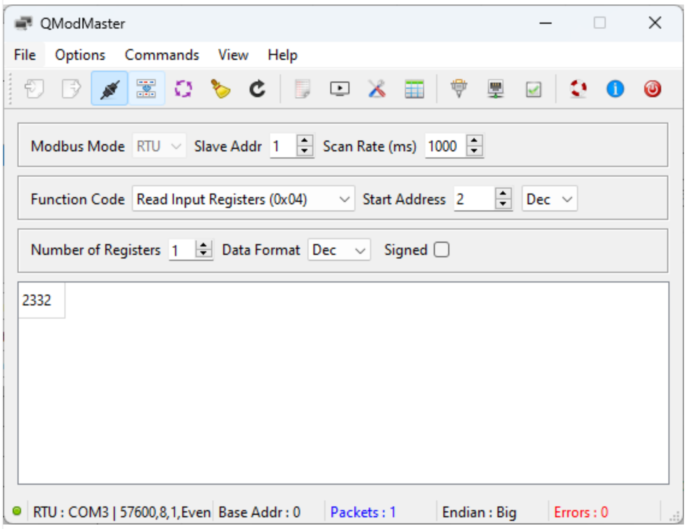


When attempting to read the temperature without adjusting the baud rate setting in qModMaster, a Timeout error occurs.



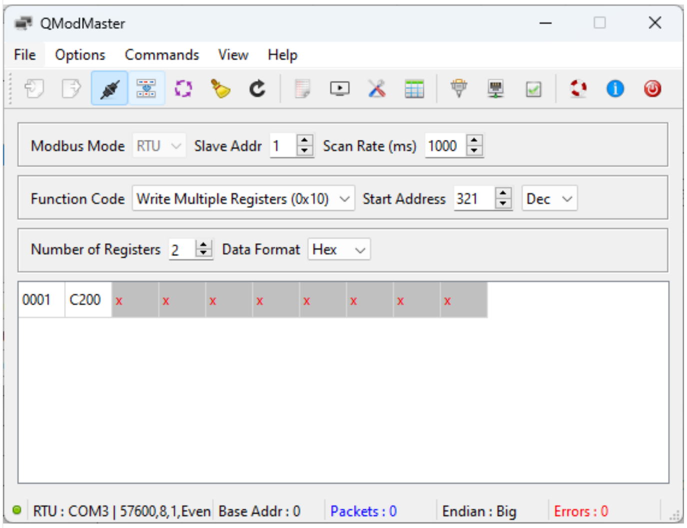
To adjust the baud rate settings, navigate to **Options** in the menu bar, then select **Modbus RTU**.

Baud: 57600



The temperature will now be read correctly without any errors.

You can check the current baud rate setting in the status bar at the bottom of the window.



To change the baud rate back to 115200, use the following settings and send them to the sensor while the software is still configured with the current baud rate of 57600.

Function Code: Write Multiple Registers (0x10)

Start Address: 321 Dec

Number of Registers: 2

Data Format: Hex

Data: 0001 C200